Science Connection
KENTUCKY DEPARTMENT OF EDUCATION
A Collaborative Resource for Teachers
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In This Issue

A warehouse of resources from the field

Simone Parker (Trigg County High School) and Nancy Broyles (Paducah Tilghman High School), both Next Generation Science Standards (NGSS) enthusiasts, share their tried and true resources in this month's Science Connection. Parker and Broyles engage students in various activities that allow them to develop understanding of the content through multiple media presentations and the essential hands-on learning opportunities. From identifying student misconceptions to boning up on the content prior to instruction, Parker and Broyles have provided a warehouse of tools that can assist teachers as they develop instructional units aligned to ***ESS1: Earth's Place in the Universe.***

MS-HS

The Content:
By Simone Parker

ESS1.C: The History of Planet Earth

- **Continental rocks, which can be older than 4 billion years, are generally much older than the rocks of the ocean floor, which are less than 200 million years old. (HS-ESS1-5)**
- **Although active geologic processes, such as plate tectonics and erosion, have destroyed or altered most of the very early rock record on Earth, other objects in the solar system, such as lunar rocks, asteroids, and meteorites, have changed little over billions of years. Studying these objects can provide information about Earth's formation and early history. (HS-ESS1-6)**

A Framework for K-12 Science Education: www.nap.edu/openbook.php?record_id=13165&page=177

This is a great explanation of why the topic of Earth's history is such an important topic. Teachers should always read the page in the Framework to get a conceptual reference as to importance of these DCI and how this topic fits into the overall picture of science education.

I tend to start talking about this subject with my classes with the discussion of the three scientific words: law, theory and hypothesis. I have found that many of my students in high school still get these three ideas mixed up. I like to try to clear up any misconceptions before we start talking about how the Earth and moon were formed, and the evidence we have to support that theory. You can have your students research the meanings of these three words and share how they are different but yet still connected to how we use science to explain phenomena.

Scientific Law: A scientific law or scientific principle is a concise verbal or mathematical statement of a relation that expresses a fundamental principle of science, like Newton's law of universal gravitation. The law must be

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Editor's note:

Happy 2014! I hope that your winter break from the classroom has caused you to reflect on 2013 as well as plan for productive change in the new year.

This month's edition is packed with resources, insight and pedagogy direct from various colleagues across our state. This is the second of many Science Connections *built by those passionate about moving science education forward in Kentucky.*

Note the color coding of the SC articles. You will find that each piece corresponds to one or more of the dimensions selected for this month. You can access your grade band or the content by decoding the colors and the labeling.

Please share this publication with those near and far and consider what you could share with others as we all collaborate on this resource to further our understanding of the new science standards.

If you have any questions or would like to submit a piece, please contact me at christine.duke@education.ky.gov.

Practice	DCI	Crosscutting Concept
Developing and Using Models	ESS1: Earth's Place in the Universe	Cause and Effect

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confirmed and broadly agreed upon through the process of inductive reasoning.

Scientific Theory: A scientific theory is a well-substantiated explanation of some aspect of the natural world, based on knowledge that has been repeatedly confirmed throughhttp://en.wikipedia.org/wiki/Observation observation and experimentation.

Scientific Hypothesis: A hypothesis is a proposed explanation for a phenomenon. For a hypothesis to be a scientific hypothesis, the scientific method requires that one can test it. Scientists generally base scientific hypotheses on previous observations that cannot satisfactorily be explained with the available scientific theories.

Earth Science Misconceptions by Students: http://tinyurl.com/oh4tyy8

I found a helpful list of earth science misconceptions. This list helps me tackle these misconceptions at the beginning of each lesson and but those evil rumors to rest.

Khan Academy video – (10 minutes) This is a refresher course on the explanation of the formation of Earth and its early history – Note to teacher: please read the questions and comments under the video. Your students will have the same questions for you; this will help you clear up any misconceptions.
www.khanacademy.org/science/cosmology-and-astronomy/life-earth-universe/history-life-earth-tutorial/v/earth-formation

Relative and Absolute Age of Rock Resources:

- How Old is That Rock? http://tinyurl.com/lszdp38 This resource discusses how scientists date the age of rocks on Earth by using radioactive isotopes.
- Rock Dating: http://tinyurl.com/ycv5556This resource talks about relative dating and absolute dating. As an added bonus, it gives the geologic time scale condensed to one calendar year.
- Geologic Age: www.earthsciweek.org/forteachers/geoage_cont.htm This activity allows students to experience the difference between relative dating and absolute dating using real-world examples.
- Plate Tectonics: www.sanandreasfault.org/Tectonics.html This resource discusses how plate tectonics and subduction are always creating and destroying ocean floor and the age of oceanic crust.
- The History of the Ocean: http://marinebio.org/oceans/history/ This resource talks about how paleontology and how the oceans have affected the formation of the ocean floor and geologic timeline.
- USGS Geologic Timeline: http://pubs.usgs.gov/gip/geotime/time.html This is a good graphic that will help illustrate to students the geologic timeline.
- IRIS Education and Outreach: http://www.iris.edu/hq/programs/education_and_outreach/resources IRIS (Incorporated Research Institutions for Seismology) uses seismic data to understand Earth's structure and does this through a cooperative of university, secondary and elementary schools as well as other institutions. Its animations are simple and its programs are phenomenal. It e-mails "Teachable Moments" PowerPoints after major earthquakes, including statistics on the area, the quake and the damage. The best thing is everything is free!

Earth's Formation and Early History Resources:

- How did the Earth form? www.space.com/19275-moon-formation.htmlVideo and short article. (7 min.). This short video discusses the formation of the moon. The article discusses the Giant Impact, Capture Theory and Co-Formation Theory to explain how the moon might have been formed.
- Moon Formation Theory Challenged by New Study: www.space.com/15035-moon-formation-theory-challenged.html
  I love to add articles like this to my discussions. As new information is discovered or developed, students must see how we incorporate that into our teaching. I also use this to add an opportunity for writing in my class. Students love to take sides!
- Origin of the Moon: Inquiry Based Activity: http://tinyurl.com/pwbv7wa Students are evaluating the theories and the evidence that backs them up.
- Lunar and Planetary Institute Educator Resources: http://tinyurl.com/p6sos9s Everything you need to know about the moon. Scroll down the page to Lunar Formation and Geology.
- How did the Earth Get its Moon: http://tinyurl.com/le8yaka Students consider the impact our moon has on Earth and explore a theory of how the moon came to exist. Research project with extensions for older students.
- Asteroids: Formation, Discovery and Exploration: http://tinyurl.com/bm5sy8bVideo and short article (2:33). This article discusses how asteroids form, their classification and their impacts on Earth.
- Impact Cratering: http://tinyurl.com/cgfnsq5 This resource discusses the types of craters, impacts and how to determine the age of a planet or moon.

The Content:
By Nancy Broyles

ESS1.C The History of Planet Earth

- The geologic time scale interpreted from rock strata provides a way to organize Earth's history. Analyses of rock strata and the fossil record provide only relative dates, not

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an absolute scale. (MS-ESS1-4)
- Tectonic processes continually generate new ocean sea floor at ridges and destroy old sea floor at trenches. (HS. ESS1.C GBE),(secondary to MS-ESS2-3)

I have listed a few videos that you can use to refresh yourself with the study of plate tectonics or use in your classroom with your students. Please read the questions and answers under each of the Khan Academy videos. There are great questions and answers that your students will ask you about in class.

Khan Academy: Plate tectonics Evidence of Plate Movement (13 min.)www.khanacademy.org/science/cosmology-and-astronomy/earth-history-topic/plate-techtonics/v/plate-tectonics––evidence-of-plate-movement

Khan Academy: Geological Features of Divergent Plate Boundaries (12 min.)www.khanacademy.org/science/cosmology-and-astronomy/earth-history-topic/plate-techtonics/v/plate-tectonics––geological-features-of-divergent-plate-boundaries

Khan Academy: Geological Features of Convergent Plate Boundaries (6 min.) www.khanacademy.org/science/cosmology-and-astronomy/earth-history-topic/plate-techtonics/v/plate-tectonics–-geological-features-of-convergent-plate-boundaries

IRIS YouTube Video: Stratigraphic Cross Section – Interpreting the Geology (3 min.) www.youtube.com/watch?v=VLBzMvsiYq8

Bozeman Science YouTube Video: Law of Superposition (6:22) www.youtube.com/watch?v=EadTLGMu3LI

Rock Strata and Fossil Record Resources

- Animations from IRIS: Stratigraphy http://tinyurl.com/mc7uymm
- Handout to go with the animations: http://tinyurl.com/nyyl2pb
- Relative Age Activity on Stratification: www.geosociety.org/educate/LessonPlans/Relative_Age.pdfThis exercise will introduce your students to the concept of relative age dating and allow them to practice their new skills by determining the age sequence of geologic events in a cross section.
- Tracing Evidence of Geologic Time Using Fossils: http://edquestscience.com/pdf/ES-PE-4notes.pdf
- Reading the Rock Record student activity: http://tinyurl.com/kxllu7h

Tectonic Processes in the Ocean Resources

- Animations from IRIS:
  How Do Plate Tectonics Work: http://tinyurl com/4zz58rc
  Handout to go with the animations: http://tinyurl.com/lpxq3va
- Snack Tectonics: http://tinyurl.com/khzbes8 This is a great activity to teach the different interactions of the types of plate boundaries. However, I use fruit roll-ups for the ocean plates instead of graham crackers. Fruit roll-ups are less dense than graham crackers and will subduct under the graham cracker plates.

Parker and Broyles have a wealth of experience and are willing to answer any questions that you might have regarding these resources.

Both emphasize understanding the standards to develop a coherent, integrated unit is essential. They can be reached at simone.parker@trigg.kyschools.us and nancy.broyles@paducah.kyschools.us, respectively.

What’s a model all about?

Richard DeLong
KDE Instructional Consultant

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What is a model? Are paper airplanes, plastic hearts, computer simulations, children’s toys and time-distance graphs models? Students are asked to develop and use many types of models in the NGSS. Developing and using models is one of the eight science and engineering practices. Steven W. Gilbert (2011, p. 3) defines a model “as a system of objects, symbols and relationships representing another system in a different medium” and that models “function in analogy.”

Examples of models

Models come in different forms. Models can be concrete items such as physical replicas, mockups and scale models. Some models are pictorial, maps, drawings and illustrations. Models can be mathematical in the form of graphs, formulas and equations, or verbal such as analogies and descriptions. Models may use technology such as computer simulations and games. Lastly, there are symbolic models such as the letters and words used in this newsletter. When do you not use a model? Models are not necessary when you can work with the target being modeled or when the real object or process being studied is accessible.

Students misconceptions about models

Students have several misconceptions about models. Page Keely and Joyce Tugel (2009, p. 77-78) summarized research identifying common student misconceptions regarding models. Students think that models are “physical copies of the real thing failing to recognize models as conceptual representations.” Lower elementary students have a basic understanding of how models are used but have perceptual trouble evaluating and developing models. Students in general “lack the notion of the usefulness of a model as being tested against actual observations” and think that changing

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Examples of models in several categories (Gilbert 2011 p. 5)

Class of Models	Examples
Concrete Models	Scale Models Mockups Figurines
Pictorial/Graphic Models	Blueprints Photographs Diagrams
Mathematical Models	Formulae and Equations Graphs Topographic Maps
Verbal Modes	Descriptions Scripts Directions
Simulation Models	Simulation Games Cockpit Simulators Crash Test Dummies
Symbolic Models (Semiotic Models)	Words, Numbers Mathematical Figures Stoplights, Stop Signs

a model is simply replacing a part that is wrong.

Students also "have difficulty distinguishing between observations and the use of a model to explain theory," and students fail to recognize the explanatory power of more abstract models. Lastly, students are confused when presented multiple models and think that each model represents a different part of what is being modeled and that only one model is the correct one.

Modeling in the NGSS

Modeling in the NGSS focus on conceptual models, and the *Framework for K-12 Science Education* states (2012 p. 56), "Building and understanding of models and their role in science helps students to construct and revise mental models of phenomena. Better mental models, in turn, lead to a deeper understanding of science and enhanced scientific reasoning." The NGSS are weighted heavily in modeling as the primary science and engineering practice. Nearly 22 percent of the performance expectations use modeling as the primary science and engineering practice, more than any other.

Number of Performance Expectations Using Modeling by Grade in Kentucky

Grade	% Performance Expectations Using Modeling
K	10
1	0
2	18
3	7
4	21
5	31
6	47
7	25
8	11
HS	24

"Virtually anything we create to represent something else is a model" (Gilbert, 2011, p. 6) and modeling is a prominent practice in the NGSS. Models serve as means to make students' thinking visible and are important to instruction. It is critical for science teachers to have a clear understanding of what models are and are not, as well as their benefits and limitations.

Gilbert, S.W., 2011. *Models-Based Science Teaching,* United States: National Science Teachers Association Press.

Keely, P., and Tugel, J, 2009. *Uncovering Student Ideas in Science (Vol. 4) 25 New Formative Assessment Probes,* United States: National Science Teachers Association Press.

National Research Council, 2012. *A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas.* Committee on a Conceptual Framework forNew K-12 Science Education Standards, Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington D.C.: The National Academies Press.

KCAS Math and Science require instructional focus on sense-making

Debbie Waggoner
KDE Regional Instructional Specialist

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The Kentucky Core Academic Standards for math and science have many similarities; both the Common Core State Standards for Mathematics (CCSSM) and Next Generation Science Standards (NGSS) require shifts in instruction. A few of the instructional shifts that are common to both subjects include:

- Each has more FOCUS so ideas are developed fully each year instead of repeating the exact same ideas and skills. This means teachers teach fewer concepts each year but need to go into greater depth on those ideas prioritized in the standards and performance expectations.
- Each has COHERENCE so students connect learning across grades in a progression of knowledge, and students can build new understanding on foundations built in previous years. This means teachers build on deep conceptual understanding as each standard is not a new event but an extension of previous learning.
- Each focuses on DEEP UNDERSTANDING so students gain real conceptual understanding and not just merely memorize isolated facts and procedures. This means teachers must provide opportunities for students to confront misconceptions and to demonstrate understanding by applying concepts and ideas to new situations and writing and speaking about their understanding.
- Each require students to use APPLICATIONS of INTERCONNECTED content in the REAL WORLD so students are expected to use the math/science in context by

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choosing the appropriate concept for an application even when they are not prompted to do so. This means teachers must provide opportunities for students to apply content through a variety of different approaches and situations, including modeling and making and critiquing arguments so students better understand the world around us.

There are additional instructional shifts required in each discipline, but these are the shifts common to both math and science that increase academic rigor from previous standards.

Another commonality between the Kentucky Core Academic Standards for math and science is the focus on disciplinary practices. The Science and Engineering Practices are listed on the left and the Mathematical Practices are listed on the right in the chart below. Notice the focus on sense-making emphasized in the highlighted sections of each.

Science and Engineering Practices (KCAS/NGSS)	Mathematical Practices (KCAS/CCSSM)
1. ***Asking questions*** and ***defining problems*** 2. Developing and using models 3. Planning and carrying out investigations 4. Analyzing and ***interpreting*** data 5. Using mathematics, information and computer technology, and computational thinking 6. ***Constructing explanations*** and designing solutions 7. ***Engaging in argument from evidence*** 8. Obtaining, ***evaluating*** and ***communicating information.***	1. ***Make sense of problems*** and persevere in solving them. 2. ***Reason*** abstractly and quantitatively 3. ***Construct viable arguments and critique the reasoning of others.*** 4. Model with mathematics 5. Use appropriate tools strategicly 6. Attend to precision 7. Look for and make use of structure 8. Look for and ***express*** regularly in repeaated ***reasoning.***

The foundation for sense-making is fundamental to the learning goals in each set of standards. So how do teachers make sure there is a focus on sense-making in their classrooms? Having regular, well-orchestrated, productive discussions as an essential part of instruction cannot be an add-on. Teachers may not have ever experienced instruction based on discourse that promotes sense-making, so professional learning with informative resources is essential.

In mathematics the term "math talk" often is used to describe the discourse needed for students to discuss their mathematical thinking and reasoning. Several videos of this in action can be found at Marilyn Burns' math solutions website http://mathsolutions.wistia.com/projects/7191d658c1.

In science, the term "productive talk" is used to describe well-guided talk – scaffolded reasoning talk and discussion – that links content, core ideas and thinking practices through productive student discussions.

Several videos of this in action can be found at The Inquiry Project Talk Science Library of Resources website at http://inquiryproject.terc.edu/prof_dev/library.cfm.

Resources:

www.achieve.org/publications/implementing-common-core-state-standards-role-elementary-school-leader-action-brief
www.achieve.org/publications/implementing-common-core-state-standards-role-secondary-school-leader-action-brief

http://learningcenter.nsta.org/products/symposia_seminars/Ngss/files/ConnectionsBetweenPracticesinNGSSCommonCoreMathandCommonCoreELA_2-12-2013.pdf

KCAS Connections

Connection to engineering within NGSS ESS1: Earth's Place in the Universe

Mindy Curless
STEM Consultant

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None of the Performance Expectations (PEs) from grades K-12 with Disciplinary Core Ideas that include ESS1 are integrated engineering PEs (marked with an asterisk (*) after the PE). Does this mean that engineering has no place in teaching science related to ESS1: Earth's Place in the Universe? No. Engineering *is* relevant to understanding Earth's place in the universe, but why? How? And how would an educator know? To understand, let's quickly review how engineering is included in the *Framework for K-12 Science Education*, and how the intended learning is translated into NGSS.

The Framework includes Engineering, Technol-

BOX 8-2 of the *Framework for K-12 Science Education*, page 203

CORE AND COMPONENT IDEAS IN ENGINEERING, TECHNOLOGY, AND APPLICATIONS OF SCIENCE

Core Idea ETS1: Engineering Design

- ETS1.A: Defining and Delimiting an Engineering Problem
- ETS1.B: Developing Possible Solutions
- ETS1.C: Optimizing the Design Solution

Core Idea ETS2: Links Among Engineering, Technology, Science, and Society

- ETS2.A: Interdependence of Science, Engineering, and Technology
- ETS2.B: Influence of Engineering, Technology, and Science on Society and the Natural World

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ogy and Applications of Science as Disciplinary Core Ideas, along with the Physical Sciences, Life Sciences, and Earth and Space Sciences. The table shows how engineering is included in the Framework. In moving from the Framework to NGSS, Engineering Core Idea ETS1, Engineering Design, was incorporated in two ways: as Engineering Design grade band PEs and as Integrated Engineering PEs at each grade level. However, Engineering Core Idea ETS2, Links among Engineering, Technology, Science and Society, is incorporated into NGSS as crosscutting concepts – ETS2.A (Interdependence) and ETS2.B (Influence). An example is included below.

MS-ESS1-3 Earth's Place in the Universe

Students who demonstrate understanding can:

MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system. [Clarification Statement: Emphasis is on the analysis of data from Earth-based instruments, space-based telescopes, and spacecraft to determine similarities and differences among solar system objects. Examples of scale properties include the sizes of an object's layers (such as crust and atmosphere), surface features (such as volcanoes), and orbital radius. Examples of data include statistical information, drawings and photographs, and models.] [*Assessment Boundary: Assessment does not include recalling facts about properties of the planets and other solar system bodies.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data Analyzing data in 6-8 builds on K-5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. • Analyze and interpret data to determine similarities and differences in findings.	**ESS1.B: Earth and the Solar System** • The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit around the sun by its gravitational pull on them.	**Scale, Proportion and Quantity** • Time, space and energy phenomina can be observed at various scales using models to study systems that are too large or too small. - - - - - - - - - - ***Connections to Engineering, Technology and Applications of Science*** **Interdependence of Science, Engineering and Technology** • Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems.

This 6th grade PE incorporates the DCI ESS1.B: Earth and the Solar System, the S&E Practice of Analyzing and Interpreting Data, the Crosscutting Concept of Scale, Proportion and Quantity, and the Connections to Engineering, Technology, and the Applications of Science through the Interdependence of Science, Engineering and Technology as a crosscutting concept. It's important to remember that to teach to the vision of the Framework, we must include the important interplay between technological advances and scientific discovery. It's empowering for both students and teachers to realize how human ingenuity and problem solving continue to advance our understanding of the universe and all aspects of science. Chapter 8 of the Framework, and Appendix J of NGSS: Science, Technology, Society and the Environment, are valuable resources for understanding the intent and learning progressions for these engineering and technology ideas. Included below is a summary of the learning progression for Interdependence of Science, Engineering and Technology taken directly from Appendix J. Even this subset of Appendix J is helpful for understanding the intended learning and easily applied in the context of the PEs associated with ESS1: Earth's Place in the Universe.

1. Interdependence of Science, Engineering, and Technology (Appendix J)

K-2 Connections Statements	3-5 Connections Statements	6-8 Connections Statements	9-12 Connections Statements
Science and engineering involve the use of tools to observe and measure things.	Science and technology support each other. Tools and instruments are used to answer scientific questions, while scientific discoveries lead to the development of new technologies.	Engineering advances have led to important discoveries in virtually every field of science and scientific discoveries have led to the development of entire industries and engineered systems. Science and technology drive each other forward.	Science and engineering complement each other in the cycle known as research and development (R&D). Many R&D projects may involve scientists, engineers, and others with wide ranges of expertise.

If we just play close attention

Ellen Sears
KDE Effectiveness Coaches

ALL

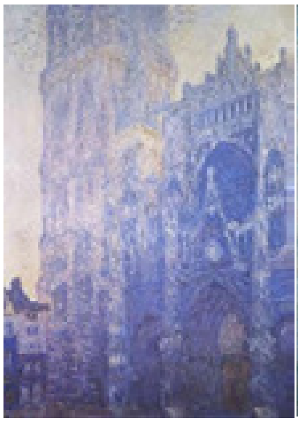

Fig.1

Fig.2

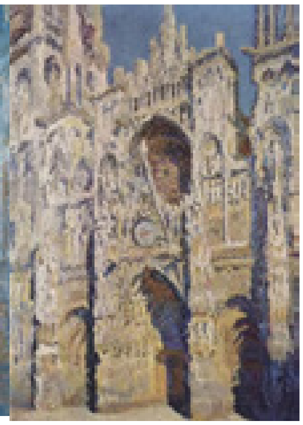

Fig.3

"For me, a landscape does not exist in its own right, since its appearance changes at every moment; but the surrounding atmosphere brings it to life – the light and the air which vary continually. For me, it is only the surrounding atmosphere which gives subjects their true value."

Claude Monet

Three Studies of Rouen Cathedral 1894

Fig. 1. - **Claude Monet**: *"The Portal of Rouen Cathedral in morning light, harmony in blue"*. 1894. Paris, Musée d'Orsay

Fig. 2. - **Claude Monet**: *"The Portal of Rouen Cathedral in morning light, harmony in blue"*. 1894. Washington, National Gallery of Art (www.nga.gov)

Fig. 3. - **Claude Monet**: *"The Portal of Rouen Cathedral (soleil), harmony in blue and gold"*. 1893. Paris, Musée d'Orsay

Monet was fascinated by the interplay between light and the natural and built landscape, and his series of studies of Rouen Cathedral from 1894 are one of the most detailed examinations of how light changes over time and through different weather that any painter has ever undertaken.

Water Lilies is a series of approximately 250 paintings that all have more or less the same subject – the aquatic flowers, pond and elegant Japanese bridge of Monet's gardens in Giverny, a small village northwest of Paris. As one local guide to Giverny says:

"*Monet painted his pond [and] his bridge repeatedly, because for him [they] were never the same. What he wanted to render was not especially a flower or a bridge, but the light on them, the air that wraps them. And the light changes all the time.*"

Grade Band Endpoints for ESS1.B

Seasonal patterns of sunrise and sunset can be observed, described and predicted. Students can make their own observations in school and at home. Students can compare and contrast the differences in light and shadow. Students can make these observations at different times of the year and notice differences. Using apps (photography, time lapse) students can observe and collect evidence about the seasonal differences, patterns of sunrise and sunset, and how an artist might use this data in their work. Students could use evidence collected from their observations and other data to think about cycles and how the same landscapes can be observed through repeated cycles of seasons, day and night to further their understanding.

The orbits of Earth around the sun, together with the rotation of Earth about an axis between its North and South Poles, cause observable patterns.

These include day and night; daily and seasonal changes in the length and direction of shadows; and different positions of the sun at different times of the day, month and year.

We can discover a never-ending world of possibilities in a single environment if we just pay close attention to how things change when we "see them under a different light." And like the late 19th century artists, study and embrace scientific research into color and light.

Earth's spin axis is fixed in direction over the short term but tilted relative to its orbit around the sun. The seasons are a result of that tilt and are caused by the differential intensity of sunlight on different areas of Earth across the year.

Relating the science & engineering practices to the TPGES

Audrey Harper and Ellen Sears
KDE Effectiveness Coaches

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As this month's focus is centered on the practice of *Developing and Using Models*, this article will explore this practice through the lens of Domain 1 of the Kentucky adapted Framework for Teaching, which provides the language of effective teaching for the Teacher Professional Growth and Effectiveness System (TPGES). The examples and alignments included are generalized and certainly not all inclusive. We encourage Personal Learning Communities (PLCs) to identify specific areas of alignment and congruency for their needs and share those with others because, like the new standards advocate, it is through inquiry and investigation that a deep understanding is constructed.

Domain 1: Planning and Preparation

1A: Knowledge of Content and Pedagogy

Not only are teachers well versed in the content specific to the discipline, but they also are aware of the pedagogical approaches that are best suited to learning in the discipline. Teachers know when it is appropriate to plan for students to develop or use models to demonstrate or develop understanding. They are aware of typical student misconceptions, and they plan to help the students dispel them. This may include a plan for students to construct and/or test a model to determine if their predictions are substantiated or contradicted.

1B: Knowledge of Students

Teachers do not teach content in isolation of students, so they must bring the contextual knowledge of their students (possess knowledge of the developmental stages, learning process, students' skills, language proficiency, and interests, cultural heritage, and backgrounds) into consideration during planning for instruction. This might include planning for students to be able to demonstrate their understanding through constructing various types of models rather than one single method.

Since the practices grow in complexity across the grades, teachers also must understand the progression of concrete to abstract models. Designing and using models begins in K-2 and builds upon these foundational experiences at each grade band.

1C: Setting Instructional Outcomes

When teachers set instructional outcomes, they describe what students are expected to learn. The language of this component is congruent to a guiding principle of the practices that advocates that the practices are not teaching methods, but they represent what the students are expected to do. Students must be able to demonstrate their understanding of important ideas through developing and using models when appropriate.

For this component, it is important to ensure that the instructional outcomes are differentiated and encourage the students to take risks. This is critical in the development and testing of models as students acquire an understanding of the world around them.

1D: Demonstrating Knowledge of Resources

Teachers use discretion when selecting resources to ensure alignment with learning outcomes and accessibility for students. When students develop and use models, they need resources to create diagrams, physical replicas, computer simulations and a variety of other representations. Expert teachers look beyond the school for resources that will assist students in their academic pursuits and ensure that they are appropriately challenging for every student.

1E: Designing Coherent Instruction

All of the previous components build up to the design of coherent instruction. Teachers plan for high-level cognitive engagement for students that align with the instructional outcomes. Teachers must have a clear understanding of the practices so they can sequence instruction and inquiry to advance student understanding. Additionally, teachers include differentiation for instructional groups and allow adequate instructional time. (This should be visible during observations through Domain 3: Instruction.)

Since students can be expected to evaluate and refine models through an iterative process, teachers need to consider this factor when planning instruction. When new evidence is uncovered or flaws develop, students might need to revisit their models to adjust or modify them.

1F: Designing Student Assessments

Teaching includes both the assessment *of* learning and *for* learning. The assessments that teachers design to assess a student's abilities to develop and use models should include formative assessments with an opportunity to adjust or modify instruction to ensure student understanding. Assessments should align with instructional outcomes and enable both the teacher and students to use the assessment data. Students also may be involved in designing the assessment by creating a rubric to evaluate their models. Teachers should plan for student choice in creating and using the models and ensure that they are authentic or applicable to the real world when appropriate.

How the Earth's systems work is a fascinating and complex topic that fits well with using models.

Elizabeth Schmitz
Executive Director, Kentucky Environmental Education Council

ALL

In 1st grade, students can study PE 1-ESS1-1 and 1-ESS1-2 by going outside in the early winter and early summer to track the movement of the sun across the sky. Using their fists as a measure, students calculate the "number of fists" that the sun is above the horizon throughout the day at these different times of year. They then use their data to graph (model) the results of their investigation. (See photo. Photo Credit: Vivian Bowles, Kit Carson Elementary, Madison County.)

Analyzing graphs and charts based on collected data.

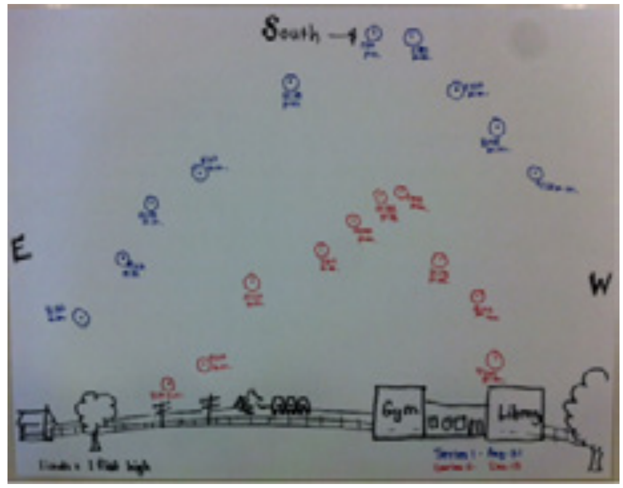
Simulations (kinetic models) are a fun way to teach both the water cycle and the carbon cycle. When students experience the journey of a molecule of water by *becoming* that water molecule, they begin to engage in a concept that may otherwise seem abstract or irrelevant to their daily lives.

To teach students in grades 5-8 about the water cycle, you might try the Project WET activity called "The Incredible Journey." In this activity, students become a water molecule and roll dice at various stations (e.g., iceberg, cloud or river), learning about how water changes form, moves from place to place and how long it is stored in its various catchments. Students keep track of their journey by mapping it on paper as they travel. This activity supports 6-ESS2-4.

To become certified as a Project WET teacher and obtain this outstanding K-12 curriculum, contact LaJuanda Haight Maybriar at the Kentucky Division of Water at (502) 564-3410 to learn about upcoming trainings or arrange training in your area.

To teach the carbon cycle in middle or high school, I recommend a modified version of the Incredible Journey.

Creating models from collected data (distance of sun above the horizon) leads to…



Students experience the carbon cycle twice: before and after the Industrial Revolution. They then compare and contrast their two different journeys by looking at beads collected at each station throughout their journey or reviewing notes made by recording their travels on paper. Developed in Kentucky, this activity is available from the National Oceanic and Atmospheric Administration at http://oceanservice.noaa.gov/education/discoverclimate/NOAA_Activity%2010_The-Incredible-Carbon-Journey.pdf. This activity supports HS-ESS2-6 and HS-LS2-5.

Formative assessment practices

Rae McEntyre, NBCT
Assessment Liaison

ALL

It is important to identify the knowledge, skills and concepts students would need to master for them to access a performance expectation. In a like manner, you would want to perform checks along the way to gauge student understanding. These checks are formally known as formative assessments. These assessments, however, do not need to be formalized. Below are examples connected to specific performance expectations:

2-ESS1-1 Use information from several sources to provide evidence that Earth events can occur quickly or slowly.

The skill students would need to master to meet this standard, and is important in science, is the ability to identify evidence. Understanding Science (http://undsci.berkley.

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edu) defines evidence as:

Test results and/or observations that may either help support or help refute a scientific idea. In general, raw data are considered evidence only once they have been interpreted in a way that reflects on the accuracy of a scientific idea.

You could gauge your students' ability to identify and understand evidence through the use of a card sort. Students are provided with a group of cards and are asked to classify objects or ideas. With 2nd graders (for this performance expectation) you would want to focus on two categories: What is Evidence, and What is Not Evidence. Some possibilities on your sorting cards could include:

- chart/graph
- data
- talk to a neighbor
- something you already know
- something you read
- measurement
- personal opinion
- prediction
- talk to an expert
- a photograph
- something you saw in a movie

In small groups, students would be asked to sort their cards into the two categories. The discussion that students have during the sorting may help reinforce the teaching as they speak with one another. As you walk around during the sorting activity, you may hear some ideas that you can address with the class as a whole.

6-ESS1-1 Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.

There are many misconceptions students bring concerning the Earth-sun-moon system. One of those misconceptions is the notion of scale: the relative size of the sun, moon and Earth, and the relative distances between these bodies. A formative assessment activity you could use to help unearth student misconceptions is "Commit and Toss." This activity is one that allows you to ascertain your students' existing knowledge while allowing complete student anonymity.

You will pose a question related to the content/concept (e.g., Why does the length of daylight increase as we move from December to June?). Students are asked to answer this question on a piece of paper and then crumble it into a ball. When a signal is given, the paper balls are tossed around the room until a signal is given to stop. Students will then pick up one paper ball close them and share the ideas and thinking that are on the piece of paper. These ideas can be charted to determine if themes are prevalent, which can then help as you continue to plan and revise your lessons.

(These formative assessment activities were taken from *Science Formative Assessment* by Page Keeley.)

Science for All

Reaching English language learners: A schoolwide effort

Amy Treece
Instructional Specialist, OVEC

ALL

"How do I fully accommodate the needs of every learner in my classroom? All of my students need something different to be successful, and I don't know where to begin."

If you have found yourself asking similar questions or making similar comments, you are not alone. As educators embark upon their daily routines, many become overwhelmed with the challenges encountered when designing instruction that meets the needs of students who do not speak a common language. Unfortunately, providing mainstreamed English language learners (ELLs) the needed accommodations in science and other content areas continues to be an ongoing challenge for most teachers. Persida and William Himmele (2009) supported the need for changing instructional practice by recognizing that "educating ELLs well must be a schoolwide effort, with everyone – administrators and faculty alike – understanding the importance of their role in the content learning and language acquisition process (p. viii)."

As teachers begin to design instruction, they should engage in professional learning that develops their understanding of the content and language acquisition process for ELLs. Himmele and Himmele (2009) outline a five-component framework for designing instruction that will lead to growth in content knowledge and language development organized around the acronym CHATS:

C – Content Reading Strategies

H – Higher-Order Thinking Skills

A – Assessment

T – Total Participation Techniques

S – Scaffolding Strategies

The CHATS framework enhances content development while attending to the language development needs of ELLs. According to *A Framework for K-12 Science Edu-*

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cation, "all individuals, with a small number of notable exceptions, can engage in and learn complex subject matter … when supportive conditions and feedback mechanisms are in place and the learner makes a sustained effort." Educators have the responsibility to provide their students with a fair opportunity to learn. Placing an emphasis on science education from kindergarten through grade 12 will have tremendous effect on developing extensive background knowledge necessary for a rich educational experience. "For students with limited language skills, the absence of opportunities to engage in science learning deprives them of a rich opportunity for language development that goes beyond basic vocabulary (p. 283)."

While acknowledging that attaining linguistic skills can be a rigorous and daunting task for many ELLs, educators must recognize the significance in providing high-quality instruction and rich learning experiences within their classrooms. Using research-based practices to build knowledge in young learners will lead to increased student learning. Strong teaching practices, such as the CHATS framework, will make the goal of achieving academic success attainable for all learners regardless of socioeconomic class, gender, language, background or national origin.

References

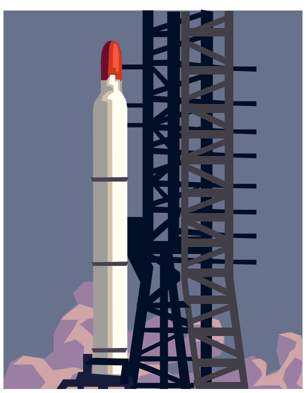
Himmele, P. & Himmele, W. (2009). The language rich classroom a research-based framework for teaching English language learners. Alexandria, VA: ASCD.

National Research Council. (2012). A framework for k-12 science education practices, crosscutting concepts and core ideas. Washington, D.C.: The National Academies Press.

Challenger Learning Centers: A resource that is "Out of this World!" Inspiring – Exploring – Learning

Kathy Anderson
Gifted and Talented Program Consultant

ALL



Are you looking for a fieldtrip or activities that will engage gifted and talented or high-ability students plus offer acceleration and enrichment related to Earth's place in the universe (ESSA1)? The Challenger Learning Centers offer many educational opportunities in mathematics, science and technology for everyone – educators, students and parents! I took my students to the Challenger Learning Center at Shawnee High School in Louisville. It was a very memorable trip for my students and for me.

The Challenger Learning Centers were developed after the Challenger tragedy in 1986 and were established in honor and remembrance of all of those who perished in the Challenger accident. The families of the STS51-L crew decided to create a living memorial to their loved ones. In 1988 the first Challenger Learning Center opened at the Houston Museum of Natural Science.

The Challenger Learning Centers are a cross-curricular learning experience. Not only are students coming in to contact with hands-on activities in science, but they also are working on math, engineering, language arts and social studies. The centers are working to align the program to the Next Generation Science Standards. As of now, the programs are designed to reflect academic standards such as the National Science Education Standards and the Curriculum and Evaluation Standards for School Mathematics.

Inside the Space Station

Photos from Hazard, KY CLC www.clcky.com/

The Challenger Learning Centers and the activities that are available on their websites are great for advanced learners because they offer problems that require critical thinking and problem solving. This is a wonderful 4th grade through high school resource that offers hands-on and real-world problems that take the students deeper into the science and math curriculum. Many of the problems also involve teamwork with at least one or two other people. For GT students, this is an opportunity to practice socialization and learning to work with others – a skill that is sometimes a challenge for GT or advance-level students.

There are three sites in Kentucky: Paducah, Louisville and Hazard. All of the centers offer virtual space-centered trips. One of the trips allows students to "Return to the Moon" while recovering and repairing a damaged space probe. Students also study soil and metal samples from the lunar surface. Another virtual experience is called "A Rendezvous

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The Space Station Assembly Team

with a Comet." In this virtual journey, students must plot a successful course to rendezvous with a comet and launch a probe to collect the data. Summer camps and other programs such as Lego Robotics (Paducah Center) are available through the centers. The website of each center is packed with classroom activities and professional development opportunities

If you would like more information regarding the Challenger Learning Centers, visit these websites or contact Kathie Anderson, GT program consultant at the Kentucky Department of Education:

- Louisville Challenger Learning Center: www.clcky.com/
- Paducah Challenger Learning Center: www.clcpaducah.org/index.htm
- Hazard Challenger Learning Center: www.clcky.com/index.html

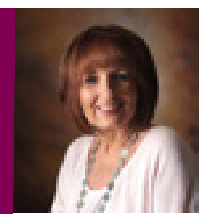
Professional Learning Opportunities

2013-14 Professional Development Opportunities

Presented by PIMSER at the University of Kentucky College of Education

Outstanding Formative Assessment

... a close focus 1-day workshop



Presented by author and assessment expert Shirley Clarke, University of London
March 11, 2014

This training will introduce new examples of the elements of formative assessment (learning culture, planning, learning objectives, success criteria, talk and questioning, and feedback). Learn practical strategies for incorporating the elements of formative assessment in the classroom, using clips of Seamus Gibbons, an exceptional inner London teacher, to illustrate what the strategies look like in practice. The training also will highlight successful staff-development strategies.
$125 for the 1-day session

Complete details at www.rsvpbook.com/formassessoneday.

Professional Developers Institute

Using Elementary and Middle School Mathematics: Teaching Developmentally

PROFESSIONAL DEVELOPMENT EDITION

Presented by co-author Jennifer Bay-Williams
March 6-7, 2014

Supporting implementation of the CCSS-Mathematics Content and Mathematical Practices. Learn how to use the book *Using Elementary and Middle School Mathematics – Professional Development Edition* directly from one of the authors. Bay-Williams will focus on specific aspects of the book that connect to the CCSS Content and Mathematical Practices, engage you in professional development activities that are in the book and consider ways the book can

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help in your work with teachers, principals, parents and students!
$300 includes purchase of book, or $175 if you already have a copy.

Complete details at www.rsvpbook.com/pdinstitute.

KSTA's Mid-Winter Breakthrough 2014
February 7 & 8

In Association with Louisville Water Company

TAPping into the Future of Science

Friday night event: WaterWorks exhibit –

Old Water Tower - River Road, Louisville, Kentucky

Saturday sessions: Bellarmine University –

Newburg Road, Louisville, Kentucky

For more information, contact:

Clara Mackin Fulkerson, KSTA Treasurer

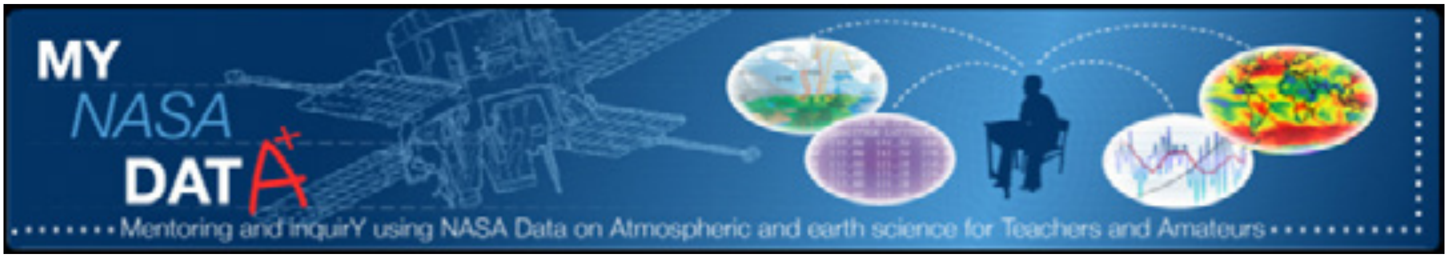
camwaf@mail.com

502-249-0458

Resources

Plan your 2014 Art and Science Discovery Field Trips and W.O.W Outreach Programming NOW!

To find more information about all the Art and Science Discovery programming available at the Living Arts and Science Center, click here.To schedule an Art Discovery Field Trip or W.O.W Outreach Program, please contact Gallery Director Jeffrey Nichols at (859) 252-5222 or at jnichols@lasclex.org.



MY NASA DATA (MND) is a tool that allows anyone to make use of satellite data that was previously unavailable. Through the use of MND's Live Access Server (LAS) a multitude of charts, plots and graphs can be generated using a wide variety of constraints. This site provides a large number of lesson plans with a wide variety of topics, all with students in mind. Not only can you use our lesson plans, you can use the LAS to improve the ones that you are currently implementing in your classroom. http://mynasadata.larc.nasa.gov/

2014 Eco-Art Contest Entries Requested

The Kentucky Department for Environmental Protection (DEP) announces the opening of the nomination period and request entries for the 2013-14 Eco-Art Contest, which is open to Kentucky high school students. The department envisions a healthy and productive Commonwealth with balanced stewardship of the land, air and water. We envision a Commonwealth where future generations enjoy an environment as good as or better than the present. The Eco-Art Contest is another way DEP supports its mission by encouraging Kentucky students to express their views on conservation, environmental protection and pollution prevention through various works of art. All nominations are due electronically by midnight on Feb. 28, 2014.

hwww.kysciencecenter.org/site/teachers/The Science Center of Kentucky is committed to supporting educators throughout our state as they encourage and inspire new generations of scientific thinkers with a "do science" attitude. That commitment is reflected in its menu of exciting, STEM-based on-site and off-site programs designed specifically to support **Next Generation Science Standards**, packaged to meet teachers' needs for the most effective field trip or off-site experience.

Join Club-ED! This educator-only resource provides you with access to online resources, classroom materials, a monthly educator e-newsletter and more.

TEACHER PREVIEW NIGHT:

Get an onsite look at some of the Science Center's school programs while enjoying the facilities with your family. Education staff will be on hand to answer any of your field trip questions or concerns. Teachers and up to three guests each will receive free admission to the Science Center's permanent exhibits, Science in Play. As a special treat, teachers and their guests also will have the opportunity to get a SNEAK PEEK in its new 3D Digital Theater. For reservations, call (502) 561-6100, ext. 6577.
Length: 5-9 p.m. Dates: Feb. 7, 2014

CIITS News

Melissa Ferrell
Division of Learning Services

ALL

Happy New Year from your CIITS Team! Let's review some highlights about CIITS. The Continuous Instructional Improvement Technology System, or CIITS, is a multi-phase, multi-year project designed to provide Kentucky public school educators with the 21st-century resources they need to carry out highly-effective teaching and learning in every classroom in Kentucky. CIITS went live statewide Aug. 1, 2011. CIITS Educator Development Suite (EDS) serves as the technology platform the Kentucky's Professional Growth and Effectiveness System (PGES), and you can read more about that here.

Science standards are scheduled to be available in January along with science resources from Discovery becoming available in late January. We encourage all educators to submit materials to your school- and district-level materials banks and, when appropriate, to the state-level materials bank.

CIITS users will notice that stronger security measures are being enforced through password reset. New Key Performance Indicators for state summative assessments and Discovery Education Assessment results are available. Student growth percentile reports now can be accessed in CIITS. For more details on these items and more of the latest CIITS news, go to CIITS News and get monthly updates and please access archived or upcoming CIITS training information here. Don't forget to follow the CIITS conversations on Twitter by using #CIITS, #PGES and @KyPGES.

Science NetLinks

Science NetLinks is a dynamic website connecting K-12 teachers, students and families to STEM resources produced by the American Association for the Advancement of Science including lesson plans, interactives and reviewed Internet resources. The lesson plan and tool databases are searchable by grade level, themes and content area. Collections spotlight various themes such as Earth Day, Summer Science fun and Science Apps. There is an afterschool collection that offers hands-on science experiments, student activity sheets, online resources, and teacher resources. Grades K-12. Tip: Check out the latest research findings about many interesting topics in Science News.

Collaboration and Connections:

The Science Connections Newsletter offers a forum for science professionals across Kentucky to collaborate and share classroom experiences. You are encouraged to share instructional strategies, resources and lessons that you have learned with colleagues across the state. Note that your entries should relate to one, or all, of the topics for the next month as noted below.
Below are the upcoming SCN focus dimensions:

Coming up:	Science and Engineering Practice	Disciplinary Core Idea	Crosscutting Concept
February	Planning and Carrying Out Investigations	PS1: Matter and its Interactions	Scale, proportion and quantity
March	Analyze and Intrepret Data	LS2: Interdependent Relationships in Ecosystems	System and System Models

E-mail your contributions to christine.duke@education.ky.gov.

All submissions are needed by the 20th of the month.